AN

ANSWER TO A CHARGE

AGAINST THE

ENGLISH UNIVERSITIES

CONTAINED IN

THE SUPPLEMENT TO THE EDINBURGH ENCYCLOPÆDIA.

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IN a Dissertation on the Progress of Chemical Philosophy, written by Mr. Brande, and prefixed to the Supplement to the fourth and fifth editions of the Encyclopædia Britannica, it is asserted, that, " excepting in the Schools of London and Edinburgh, Chemistry, as a branch of education, is either entirely neglected, or, what is perhaps worse, superficially and imperfectly taught." And it is added that " this is especially the case at the English Universities, and that the London Pharmacopœia is a record of the want of Chemical knowledge where it is most imperiously required."

As Professor of Chemistry in the University of Oxford, I am, to a certain extent, necessarily implicated in the charge here brought forward; and I naturally feel desirous of defending myself

against it; though, in the opinion of some, I may be thought to compromise the dignity of the University, in answering an accusation made by an individual not educated among its members, and probably, therefore, an incompetent judge of the scope of an academical education. But I respect Mr. Brande, both on account of the honourable rank he holds as Secretary to the Royal Society, and still more on account of his industrious exertions in the promotion of practical Chemistry; and I shall be happy if, in convincing him that he has advanced an assertion not warranted in fact, I may remove from his mind a prejudice, the existence of which I have perceived with much regret.

But I will go further than this: for even had the Author of the charge in question been one of those obscure and illiterate sciolists whom the easy courtesy of the present age would dignify with the title of Philosophers, I should still have felt it incumbent on me to repel the charge; not only in my own name, but in the name of the University also. For communities themselves are not exempted from the operation of those moral causes which are capable of affecting the reputation and existence of individuals; and the same immortal historian who informs us, that Lord Strafford's "destruction was brought upon "him by two things that he most despised, the

"people, and Sir Harry Vane," instructs us also, that the most deeply rooted form of government may be gradually undermined by causes and instruments in their origin the most trivial and ignoble.

In replying to the present accusation, I do not feel myself called upon to take any notice of that part of it which relates to the London Pharmacopœia: because, as I may perhaps have a future opportunity of shewing, its inaccuracies, whatever they may be, cannot in any propriety be imputed to the University; and, with respect to myself, I had not the honour of belonging to the College of Physicians at the time of its publication. I confine myself therefore to that part of the charge in which it is asserted, that "at "the English Universities, Chemistry, as a branch "of education, is either entirely neglected, or "superficially and imperfectly taught:" and, in the observations I may have occasion to make, I shall of course restrict myself to the consideration of my own University; only premising my belief, and this I do with sincere pleasure, that if a successful case may be made out in defence of Oxford, it may still more easily be made out in defence of Cambridge.

I propose therefore, in the first place, to inquire on general principles, in what sense and to what extent Chemistry ought to be cultivated

as a branch of education in a University like Oxford; and, in the second place, whether I have individually understood and fulfilled my duty as Professor of Chemistry in that University.

It may be maintained then, without the fear of contradiction from any fair and reasonable person, that as the Chemical Lectures delivered in the University of Oxford are intended exclusively for an academical audience, the Lecturer is not only justified in accommodating his Lectures to the particular character of the institutions of the place in which they are delivered, but is in the strictest propriety called upon to do so. Any charge moreover against the University, or the Lecturer, of imperfectly teaching this or any other branch of Science, may justly be called presumptuous, if not coupled with a knowledge of the system of education here pursued: for it may in common fairness be granted, that the University is competent to decide on the propriety of its own plans; and to condemn those plans before the grounds of them have been duly examined, may at least be called a preposterous mode of judging.

It is evident, then, to those who reflect on the subject, that the whole tenor of an academical education, so far at least as intellectual endowments are concerned, regards the general

improvement of its members, rather than their qualification for any particular profession: and hence the trite objection so often even now brought forward, that the Physical and Experimental Sciences are here neglected, can only proceed from want of candour or of information. For a candid and enlightened mind would readily allow, that though the discipline of Classical and Mathematical studies is well calculated to form the groundwork of excellence in the Physical and Experimental Sciences, the converse of this is by no means true; witness the deficiency, both with respect to taste and reasoning, in the literary productions of individuals, whose fame in other points deservedly ranks high in the scientific and professional world.

The Physical and Experimental Sciences then are not neglected in this place. They are not cultivated indeed to the same extent as in some other schools; but they are cultivated so far as is compatible with the views of a system of general education: and hence the object of the Lecturers in the several branches of those sciences is, rather to present a liberal illustration of their principles and practical application, than to run into the minutiæ of a technical, or even a philosophical detail of facts. These branches of science, in this place at least, may be considered with reference to Divinity, Classics, and Mathe-

matics, in the same light as the supernumerary war-horses of Homer's chariots; which were destined to assist, but not to regulate, the progress of their nobler fellow-coursers.

With respect to Chemistry, indeed, it is the opprobrium of that science, if science it may even yet be called, that though it has at once dazzled and ameliorated the condition of the world by the discoveries of philosophers like Davy, Scheele, and Wollaston; it has in some respects debased the character of Philosophy itself. It has been the means, that is, of elevating to the title of Philosophers a host of individuals, whose talents were just equal to that species of inductive reasoning, the nature of which has been of late years so egregiously mistaken, and its importance so absurdly maintained. That man, in truth, must be possessed of but ordinary abilities, who cannot draw a general conclusion from a number of analogous facts continually passing before his eyes; while, after all, it must be genius alone that can penetrate beyond the limits which apparently confine it, and connect at once the distant or hidden links in a chain of philosophical reasoning. It was genius in its fairest form and happiest hour, which discovered to Sir Humphry Davy the connection between the cooling power of a metallic surface, and the extinction of contiguous flame; which taught

him to extend the application of an abstract principle to the preservation of human life; and added thus a more lasting wreath of honour to his temples, than the decomposition of Potash or of all the Alkalies in nature could ever have conferred.

And undoubtedly Lord Bacon did not look forward to those easy triumphs over the mysteries of the material world, which some seem to expect from the inductive method. He only maintained, what I believe no one is now disposed to deny, that without induction founded on experiment or observation, no advances could be reasonably expected in the Physical Sciences: but a mind imbued so deeply with the spirit and matter of ancient learning was not likely to overlook the advantages to be derived from the discipline of a Classical education. And if superiority of intellect be shewn in the choice of those experiments or observations on which induction is to rest, and this I think no one will attempt to controvert, it is in the highest degree probable, that the same mind will be more or less successfully exerted in the prosecution of any particular branch of science, in proportion as its powers have been previously exercised by the discipline of general education: not indeed that education can communicate new powers to the mind, but that it improves those which it na-

turally possesses, and enables it to direct them at once to the most appropriate points of observation. In saying this however, I do not mean to disparage those self-elevating powers of extraordinary talents which occasionally are found to supersede the necessity of any education, being at once the master and scholar of themselves.

If indeed Mr. Brande had asserted, that Chemistry was imperfectly cultivated by the generality of the members of the English Universities, he would doubtless have asserted a truth; and a truth of which the reason is sufficiently obvious: since nearly ninety-nine out of every hundred there educated, are destined not for the Profession of Medicine, nor for Commerce, but for the Church, or the Bar, or the Diplomatic departments of the State. I would ask therefore any reasonable person, not whether it is likely, but whether it would be desirable, that the preparation for such grave and important duties should be interrupted by more than a passing attention to pursuits, which can only be hereafter cultivated as a liberal relaxation from severer studies and engagements. But if in after life the intervals of the more important duties should afford sufficient leisure for the cultivation of natural science, there is no reason why it may not be cultivated: and there are those

among the members of the University, and I am proud in reckoning some of them in the number of my nearest friends, who have thus contributed to the advancement not only of Chemistry, but of other branches of natural knowledge. But I need not dwell longer on that point of the charge in question which relates to the University at large. I proceed therefore to that point which concerns myself: and this is naturally the most difficult and invidious part of my task; because, in proportion as I succeed in it, I must appear to insist on my personal deserts. Perhaps, however, this difficulty will be lessened, without embarrassing the judgment of the reader, if, in subjoining a Syllabus of the three last Courses of Lectures delivered by me, I make a few observations upon its contents, and the arrangement of the subjects therein distributed.

It will be seen then, by a reference to the Syllabus, that after such introductory remarks as apply to the general principles of Chemistry, I have proceeded to the consideration of those natural agents, which, from the universality of their occurrence, must necessarily be present, unless industriously excluded, in all our scientific operations, and in all our observations of natural phenomena. Thus wherever we ourselves may be, both light and heat, and air

and water will necessarily be present also. I have been accustomed generally to illustrate these subjects by an analytical investigation of the phenomena connected with them: and after fifteen years reflection I am convinced, both from antecedent reasoning, and from the opinion of those of my hearers who were best capable of judging, that this is the best method of instruction I could have adopted.

The remaining part of the Syllabus is occupied by the more remarkable of the Inflammable Substances, and of the Acids, Alkalies, Earths, and Metals: and the experiments connected with these are calculated to shew either their most striking properties; or the methods of obtaining them for commercial and philosophical purposes; or their application in the various arts and manufactures of our own country.

In speaking of the number of Lectures in each Course, I may observe, that there is, in fact, nearly an equality between the Course delivered in this University, and that delivered at Guy's Hospital; which is justly considered the best school in London for the Physical Sciences. In Oxford, the Chemical Course consists of about thirty Lectures: at Guy's Hospital the Course consists of about forty Lectures: but when it is considered, that in the Course last mentioned, as being intended for a medical audience exclu-

sively, Pharmaceutical preparations occupy a large share of the Lecturer's attention, the difference between the length of the two Courses upon the whole is not very great.

Of the general character of the experiments I have already spoken; and shall only now add, that as the progress of discovery introduced new facts of any great importance, I have usually exhibited the experiments illustrative of those facts.

I think it here due to myself to state, that during fifteen years I have never had any assistance either in the preparation of the experiments, or in their actual exhibition: and when occasionally it has happened that an experiment has failed, I have not only been careful to investigate and explain the cause of the failure, but have repeated the experiment until it has been successfully exhibited.

As adapted to the character of an academical audience, I have taken some pains in adverting to those passages of the ancients, which indicate the early state of knowledge in parts of Natural Philosophy connected with Chemistry: but it would occupy too great a portion of these pages, to produce the numerous passages which from time to time I have collected with this view. I will however mention the two following, as among the most remarkable that have occurred

to me: in one of which, a curious electrical effect produced by the Torpedo is mentioned by Plutarch; in the other, a very singular conjecture respecting the separate nature of Light and Heat is offered by Lucretius.

Plutarch, in an account which he gives of the Torpedo, says, "It is mentioned by those who "have made the experiment, that upon pouring "water on a living Torpedo, a sensation of "numbness is felt in the hand of the person "that pours the water; the shock probably "being conveyed upwards from the body of "the animal, through the stream of the water[a]. In referring to Thomson's Annals of Philosophy for February 1817, page 149, it will be seen, that after an interval of nearly two thousand years, the same fact is mentioned by a writer who was probably not aware of the antiquity of the anecdote. The Annals mention, that in a paper written by a gentleman of the name of Todd, and read before the Royal Society on Dec. 5, 1816, the author states a circumstance respecting the Torpedo, which he has been told, he conceives, on good authority, though he never wit-

[a] Ἔνιοι δὲ ἱστορῦσι, πεῖραν αὐτῆς ἐπιπλέον λαμβάνοντες, ἂν ἐκπέσῃ ζῶσα [Νάρκη sc. Torpedo], κατασκεδαννύντες ὕδωρ ἄνωθεν, αἰσθάνεσθαι τῦ πάθυς ἀνατρέχοντος ἐπὶ τὴν χεῖρα, καὶ τὴν ἁφὴν ἀμβλύνοντος, ὡς ἔοικε, διὰ τῦ ὕδατος τρεπομένυ καὶ προπεπονθότος. Plut. Op. Moral. Wyttenb. t. iv. p. 643.

nessed it himself: the circumstance is this, that "where Torpedoes abound, boys are in the habit "of playing the following trick to those who are "not in the secret: they persuade the ignorant "boy to pour water upon the Torpedo; the "consequence of which is, that an electrical "shock is conveyed along the stream of the "water." In copying this extract, I have taken the liberty of making two verbal alterations; which however will be found to have been made merely for the sake of euphony.

The conjecture to which I have alluded respecting the distinct nature of Light and Heat, is contained in the following lines of Lucretius,

> Forsitan et rosea Sol alte lampade lucens
> Possideat multum cæcis fervoribus ignem
> Circum se, nullo qui sit fulgore notatus,
> Æstiferum ut tantum radiorum exaugeat ictum [b].

Upon the discovery announced by Herschel, some years since, that Heat is radiated from the sun, independently of Light, these lines immediately occurred to the recollection of the late Dean of Christ Church, who had the goodness to point them out to me.

I shall conclude these observations by briefly stating some of my private labours in that department of Natural Science, which has been de-

[b] Lib. v. l. 609—612.

puted to my care in this University. I do not presume, however, even to think that they are of sufficient importance to be mentioned on account of their intrinsic value: but I hope they will serve to shew, that, notwithstanding Chemistry has by no means been my sole occupation, (my other necessary engagements indeed have been always various and constant,) I have not contented myself with the bare delivery of my Public Lectures; but have dedicated such leisure, as I could spare, to the further pursuit of Natural Science.

Among the improvements which have been made in the apparatus of Chemistry, I may claim the invention of a convenient blowpipe, constructed on hydrostatic principles, the plan of which has been since very generally adopted: and to an artist who some years subsequently constructed a blowpipe on the same principles, the Society for the Encouragement of Arts and Manufactures gave a prize in the year 1813.

In 1805 I made an analysis of a new variety of Blende, which is published in Nicholson's Journal for that year. On this occasion I successfully employed the Voltaic apparatus, as a convenient instrument of chemical analysis; obtaining by its means the zinc, in a metallic state, from an alkaline solution of its oxyd: and this is, I believe, the first instance on record of the

systematic application of the Voltaic apparatus to that purpose. I had on two or three occasions previously employed it for a similar purpose, having originally been led to adopt this method, from having observed in the year 1802, that, in completing the Voltaic Circle by means of the petal of a flower perfectly white, the part of the petal communicating with one end of the electric series became red; while that communicating with the other end became green. I mentioned the fact at the time to Sir Humphry Davy, but he was then incapable of explaining it: and though his subsequent discoveries enable us to explain in part the cause of the singular effect, it still in part remains unexplained; that is, though we can now understand why, if any changes take place in the colour of the white petal, those changes should be to red and green; it is not however obvious, why any change at all should be effected.

In the Philosophical Transactions for 1814 is a Paper containing the result of some observations made by me, on the spontaneous production of Salt-Petre; from which, I think, may be deduced this remarkable theoretical conclusion, that Potassium, or the metallic base of the Vegetable Alkali, is either a component principle of some of the elements present in the formation of Salt-Petre, which are, necessarily, only Carbo-

nate of lime and atmospherical air; or is itself a compound of two or more of the principles of those elements, or of two or more of the elements themselves[c].

In the department of Geology, which at the present day ranks high among the branches of Natural Knowledge, I have laboured with much industry; and for a long time I laboured almost alone in this place. But that labour has been very amply repaid by the general taste for the pursuit, which it happily was the means of exciting in the University: and when I look at the present Geological Collection of the Ashmole Museum, but more especially when I look at those who assisted me in its formation, I may be excused, if I feel a consciousness of having rendered some service to the University in this department of Natural Science. Of the two small works which I have published in Mineralogy and Geology, the first was intended to convey some knowledge of the subject to a class of readers who would have probably been deterred by a more systematic work; the last was

[c] The terms "element" and "principle" are here used in the same relation to each other, as the early physical philosophers used the terms Στοιχεῖα and Ἀρχαί. They supposed that the former, though incapable of decomposition by common means, were not necessarily to be considered as absolutely simple substances: absolutely simple substances they expressed by the term Ἀρχαί.

intended to shew the existence and character of those difficulties which will ever be opposed to the formation of a theory of the earth; and it has not, I have reason to believe, been without its use.

I have only now to state, that the subjoined Syllabus is reprinted from an impression that I have solely used for the last three years; which will account for its silence respecting any remarkable additions to Chemical Science, that have been made during that period.

SYLLABUS

OF A

COURSE

OF

CHEMICAL LECTURES,

READ AT THE MUSEUM,

OXFORD,

IN THE YEARS 1815, 1816, AND 1817.

SYLLABUS, &c.

INTRODUCTION.

GENERAL plan of the Course.

Of Chemical Attraction—between substances of what kind, and under what circumstances, it is capable of being excited—its effects in altering the sensible properties of bodies—takes place only between definite proportions of matter.

Of the properties of a Chemical Compound with respect to those of its constituent parts—neutralization of these properties the result of their mutual saturation.

Of the different degrees of force with which one body is disposed to combine Chemically with many others, taken separately: whence the doctrine of Chemical Affinity, or Elective Attraction.

Of Analysis, or the separation of the constituent parts of a Chemical Compound. Electricity the most powerful Agent of Chemical Analysis—arrangement of the various forms of matter at the opposite Electric poles.

ON LIGHT AND HEAT.

Mutual connection of Light and Heat not universal. Prismatic division of the rays of Light, with the Che-

mical effects of these on substances exposed to their influence.

Evolution of Light and Heat not exclusively characteristic of Combustion; but in general the result, and at the same time a measure of the intensity, of Chemical action. Other sources of Light and Heat—Electricity—Compression, &c.

The terms "Caloric" and "Heat" compared.

Of the absorption, reflection, and radiation of Heat—of its transmission through various bodies; and of the economical application of the knowledge deduced from the foregoing properties.

Of the expansion of bodies by Heat: and of the specific gravity of different substances; or of the same substance at different temperatures.

Of the different states in which the same body is capable of existing under different degrees of Heat; and of various chemical processes depending on this, as Evaporation, Distillation, &c.

Of the decrease of Temperature, which takes place during the Solution of Solids, and the Evaporation of Liquids: Mr. Walker's experiments on Freezing Mixtures.

Of the increase of Temperature produced by the Condensation of Steam, &c.; and by the Congelation of Liquids.

Dr. Black's opinion of the nature of Heat deduced from the foregoing phenomena.

ON GASEOUS BODIES.

Of those substances which retain an aëriform state under every common alteration of temperature—mean-

ing of the term "Gas"; and why gaseous bodies are said to be permanently elastic.

Of the tendency which all kinds of aëriform bodies have to penetrate each other, so as to become equably mixed.

Of the means of insulating aëriform bodies for the purpose of examining their properties. Dr. Hales's Experiments—Pneumatic apparatus.

ON ATMOSPHERICAL AIR.

Of the nature of the Atmosphere considered chemically.

Why formerly supposed to be an Element—truth of this opinion doubted by Mr. Boyle, Dr. Mayow, and others; in consequence of the Chemical alteration produced in various substances by exposure to the Atmosphere.

Lavoisier's examination of Atmospherical Air by means of heated Quicksilver; and by the combustion of Sulphur, Phosphorus, &c.—consequent increase of weight, and alteration of other properties, in those bodies.

Diminution in volume and corresponding decrease in weight of the air employed in Combustion, &c.—character of this residuary portion of the air—Nitrogene Gas of modern Chemistry. Restoration of the quantity of air lost, and of the properties destroyed, during the abovementioned processes.

Comparison of the ancient and modern Theories of Combustion, &c.—Stahl's Phlogiston— Phlogisticated

and Dephlogisticated Air of Dr. Priestley—Oxygene and Azotic Gas of Lavoisier.

Of Oxygene—means of obtaining Oxygene Gas in a separate state: its remarkable properties with respect to the phenomena of Combustion: Iron made to burn in it.

Of Nitrogene—means of obtaining Nitrogene Gas in a separate state.

ON WATER.

Natural history of, as far as connected with Chemistry. Solvent power over various substances—difference between what are technically called Hard and Soft Waters.

Contained in a state of Chemical combination in many solid substances, forming a class of compounds called Hydrates.

How obtained in its purest form.

Why till lately esteemed an Element—Sir Isaac Newton's opinion respecting an inflammable principle contained in it—instances of the necessity of the presence of Water for the production of Inflammable Air—Inflammable Air produced by bringing Water into contact with ignited Iron—also by the passage of the Electric fluid through Water—proportional Oxydation of the Metals employed in the above experiments.

Lavoisier's opinion of the composition of Water—Inflammable Air burnt in contact with Oxygene Gas—proportional quantity of Water produced by this com-

bustion—hence Inflammable Air now called Hydrogene Gas.

Of Hydrogene—exists as a constituent principle of animal and vegetable matter in general—the source of flame in all the common forms of fuel. Means of obtaining Hydrogene Gas in a pure form—its properties.

ON CARBON.

Of the principle called Carbon—its wide diffusion in nature—the Diamond—Plumbago, or Black Lead.

Means of obtaining the purer forms of Carbon—its properties—its compounds.

Carburetted Hydrogene Gas, formerly called Heavy Inflammable Air—produced during the distillation of wood and coal, &c.; also in the natural decomposition of vegetable matter.

Of various compounds of Carbon and Hydrogene—oils and resinous substances, &c. Of Alkohol, or Spirit of Wine—its solvent power over resins: Varnishes, and Medicinal Tinctures—decomposition of these by water.

Of the preparation of various kinds of Ether.

ON SULPHUR.

Natural sources and forms of Sulphur—means of separating it from its compounds.

Sulphuretted Hydrogene Gas—its solubility in water: Harrowgate Water.

ON PHOSPHORUS.

Mode of procuring it from calcined bones, &c. its properties.

Phosphuretted Hydrogene Gas—remarkable inflammability of this Gas.

ON ACIDS.

Definition of, why difficult—general characters—solubility in Water—change certain Vegetable blue colours to red.

Formation of Acids partly explained in the history of Atmospherical Air—in some instances rapidly decomposed by Oils, so as to produce immediate Inflammation.

Of the Radical or Base of Acids. The same base in some instances capable of combining with different proportions of Oxygene.

Of Vegetable Acids.

ON CARBONIC ACID.

Immediate formation of, by combustion of Charcoal—produced during the process of Respiration—in what situations met with already formed—extricated from all kinds of common Marble and Limestone by other acids and by heat—Fixed Air.

Carbonic Acid Gas—specific gravity of—effects on Respiration and Combustion—Vats of fermenting Liquor—Grotto del Cane, &c.

In what proportion met with in Atmospherical Air—absorbed by Water, and other Liquors, at a low temperature; communicating to them Acid characters, &c.—Nooth's Apparatus for impregnating Water, &c. with Carbonic Acid Gas—why retained with difficulty by these Liquors.

ON SULPHURIC ACID.

Combustion of Sulphur in pure Oxygene Gas.

Sulphurous Acid Gas—composition and properties of this Gas—its solubility in Water: alteration of the properties of this solution by absorption of Oxygene.

Sulphuric Acid. Hydro-Sulphuric Acid. Means of obtaining the Sulphuric Acid of Commerce: Oil of Vitriol; Acid, or Spirit, of Vitriol—its properties: great weight; strong attraction for moisture—digested with Nitre acquires the property of readily dissolving Silver (Aqua Reginæ): important application of this compound in recovering Silver from plated ware.

Of the action of Sulphuric Acid on Starch—production of Sugar.

ON NITRIC ACID.

Mr. Cavendish's discovery of its formation by passing the Electric spark through Atmospherical Air over water.

Process for obtaining it from Nitre, &c. by means of Sulphuric Acid—relation of Nitric Acid to water; Hydro-Nitric Acid.

Decomposition of Nitric Acid, by heat; by the action of Metals, and other substances.

Nitric Acid of Commerce; Aqua Fortis—whence its occasional colour—use of in Medicine—in Engraving—in separating Gold from Silver.

ON MURIATIC ACID.

Method of obtaining it from Sea-salt by means of Sulphuric Acid—Spirit of Salt of Commerce.

Muriatic Acid digested in various ways with Nitric Acid (Aqua Regia)—the resulting liquid remarkable for its power of dissolving Gold.

Effect produced by the action of certain Metallic Oxyds on Muriatic Acid—present opinions respecting the nature of this effect. Chlorine; Oxy-muriatic Acid—application of in the process of Bleaching.

ON ACETIC ACID.

Produced at a certain stage of Vegetable fermentation—general history of Vegetable fermentation—circumstances necessary to promote it. Vinous—Acetous—Putrefactive fermentation.

Vinegar—concentrated by different means—effects thereby produced—Acetic Acid—Radical Vinegar.

Acetic Acid distilled from various Spices, &c.: Aromatic Vinegar.

ON OXALIC ACID.

Met with, in a combined state, in the Oxalis Acetosella, &c.—how separated from these.

Method of obtaining it from Sugar, Wool, Flour, &c. by digestion in Nitric Acid.

This Acid a very strong test of the presence of Lime.

ON GALLIC ACID.

Whence so called—in Vegetable substances of what nature principally found; and how separated—forms a black insoluble compound with Iron, the base of common Ink.

Of the composition of Inks, &c.—action of Lemon-juice, &c. in destroying the colour of Ink.

ON PRUSSIC ACID.

Origin of its name—various processes for obtaining it—why in general obtained in a combined state.

Prussic Acid a good test of the presence of Iron in solution;—a test also of most metallic solutions.

Prussiate of Iron (Prussian Blue)—reason why this has sometimes a green tinge; and how that tinge may be obviated.

ON ALKALIES.

Origin and subsequent application of the term.

Sir H. Davy's discovery of their metallic base, and the combination of this with Oxygene.

Combination of Alkalies with Sulphur; Livers of Sulphur.

Strong attraction for Carbonic Acid—Dr. Black's discovery with relation to this part of the subject—Caustic, and Mild or Aërated, Alkalies.

Combination of Alkalies with Acids in general; forming Salts of various characters. Definition of the generic term "Salt." Crystallization, &c. of Salts.

ON POTASH.

Potash of Commerce how, and in what state, obtained—various forms of it—Pearl-ash—Salt of Wormwood—&c. (Sub Carbonate of Potash.)

Means of obtaining the common form of Caustic Potash (Hydrate of Potash)—its properties; and use in the analysis of Minerals—Liquor Silicum. Decomposition of Potash by the Voltaic Apparatus.

Carbonate of Potash—partial decomposition by heat: Sub Carbonate of Potash.

Nitrate of Potash (Salt-Petre—Common Nitre) natural history of this salt—artificial means of obtaining it—in what manner affected by various degrees of simple heat—phenomena that take place when Nitre is heated sufficiently in contact with combustible substances—composition and manufacture of Gunpowder—theory of its detonation.

Of the Salt commonly called Oxy-muriate of Pot-

ash—explanation of its fulminating properties; also of its decomposition by heat.

Acidulous Tartarite of Potash (Cream and Crystals of Tartar)—deposited in an impure state from Wine—deflagration with Nitre—formation of Metallic Fluxes—Salt of Tartar—Acid of Tartar.

ON SODA.

Soda of Commerce—various forms of it—Natron—Barilla—Kelp—Sal Sodæ—&c. (Sub-Carbonate of Soda.)

Means of obtaining the common form of caustic Soda—properties of, and uses in the making of Soap and Glass; and why in these instances preferred to Potash.

Sulphate of Soda (Glauber's Salt) how affected by different states of the Atmosphere—great proportion of Water of Crystallization.

Of Common Salt—present opinion respecting its chemical composition—its natural history—means of obtaining it by evaporation of Brine Springs, &c.

Sub-Borate of Soda (Borax)—effects of heat on this Salt—Calcined Borax—Glass of Borax; use of in soldering Metals; in Medicine.

Of the Triple Salt, Tartarite of Soda with Potash (Rochelle Salt).

ON AMMONIA.

Composition of; and in what substances and situations met with—generated during certain Metallic solutions.

Properties of pure Ammonia—remarkable volatility—Ammoniacal Gas, rapid absorption of by Water.

Sub-Carbonate of Ammonia (Salt of Hartshorn) obtained in an impure form by distillation of bone and other forms of animal matter—produced immediately in a solid form by the mixture of Carbonic Acid Gas with Ammoniacal Gas.

Nitrate of Ammonia—decomposition of by the lower degrees of heat—effects of the higher degrees of heat on this Salt—inflammable without addition of any other substance.

Of Sal Ammoniac—its natural history—various modes of obtaining it—produced immediately in a solid form by the mixture of Muriatic Acid Gas with Ammoniacal Gas—in what manner affected by heat. Uses; in soldering Metals—in tinning Iron—in obtaining pure Ammonia and Sub-Carbonate of Ammonia: processes for this purpose.

ON EARTHS.

Sir H. Davy's discovery of their metallic base.

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